09/341637
Entire specification
Art. 34
69 Rec'd PCT/PTO 15 JUL 1999

METHOD AND APPARATUS FOR STRIP-COATING A METALLIC STRIP-SHAPED SUBSTRATE WITH A PLASTIC STRIP AND STRIP THUS ~~OBTAINED~~

The invention relates to a method for strip-coating a metallic strip-shaped substrate with a thin strip of plastic, an apparatus for carrying out the method as well as to the coated strip obtained with the method.

There are at least two methods known for manufacturing a coated product comprising a metal substrate and a plastic layer adhering to it, namely film-laminating and extrusion-coating.

In the case of film-laminating, a finished plastic film is unrolled and applied onto the metal substrate, as disclosed in e.g. WO 93/24324.

In the case of extrusion-coating a sheet of plastic is applied onto the metal substrate directly or virtually directly from an extruder, as disclosed in e.g. EP 0 067 060 A1.

In the case of the first method a roll of finished film is taken as starting material. A problem in making a roll of film is rolling it up. The film tends to stick to itself so that the windings cling to each other. Because in its rolled up state the film shrinks somewhat, the roll has to be rolled up loosely to enable it to be unrolled once again in a controlled way. Inevitable stresses in the film then easily cause edge build-up, the roll becomes unround, and the film displays spacing tracks when being unrolled. Among other things this makes the film incapable of being unrolled without difficulty at a sufficiently high speed; if this does succeed then there remains the problem that at higher rolling off speeds electrostatic discharge symptoms need to be reckoned with. To avoid such difficulties additives are added to for example household foils; in the case of film-lamination this solution offers

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no remedy because the additives unacceptably reduce the capacity to adhere to the metal substrate.

On the face of it extrusion-coating would therefore seem an interesting alternative, and so it is for a small number of applications, namely those whereby the plastic involved has the correct adhesion properties in molten state. When this is no longer the case, or not adequately so, and molecules need to be incorporated in the plastic to migrate to the surface in order to accomplish adhesion, in the case of extrusion-coating the problems occur, at least where a high coating speed is desired. This is because adhesion groups only migrate fast enough, i.e. within tenths of a second, if a sufficiently high temperature can be maintained during the coating. This is only possible when coating onto one side of the substrate. The required high temperature then also makes it impossible subsequently to coat the other side because the previously applied coating becomes unacceptably damaged on the second exposure to the high temperature. Even non-subsequent but simultaneous two-sided extrusion-coating is no solution because in the case of extrusion-coating the slightest deviation in substrate thickness and the slightest disturbance in the process would cause unstable process operation and consequently coating differences and inhomogeneities on each side.

The problems surrounding the procedures outlined are resolved or at least largely reduced if worked in accordance with the invention.

The method in accordance with the invention is characterised in that it comprises in combination the stages

(i) in-situ casting of a plastic strip;

(ii) leading the plastic strip around a preferably internally water-cooled cooling roll;

(iii) leading away the plastic strip until the plastic strip production is underway and

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stabilised;

(iv) bringing the plastic strip and the substrate up to speed and heating the substrate to a temperature of the substrate close to or above the softening temperature of the part of the plastic strip facing the substrate;

(v) pressing the plastic strip onto the substrate and where applicable breaking off the plastic strip and stopping it being led away, while the substrate and the cooling roll are connected by the plastic strip;

(vi) coating the substrate with the plastic strip at high speed.

This achieves the effect of enabling a considerably thinner plastic layer to be applied onto the metal strip in a controlled and economically viable manner.

It is remarked that US 5,407,702 discloses a method for coating a metal strip with a polymer extrudate which extrudate after extrusion is firstly brought into contact with a surface having a temperature which will promote sticking or clinging of the extrudate thereto. A typical temperature for this purpose is said to be in the range of about 120 °C to 180 °C.

The invention is also embodied in an apparatus for the continuous strip-coating of a metal substrate with a layer of plastic.

Finally the invention is further embodied in a strip-coated packaging steel.

The invention will now be further illustrated by reference to the drawing comprising Figures 1, 2 and 3 each of which show a possible line drawing for coating in accordance with the invention, and several non-limitative examples with references to the Figures.

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Example 1

An ECCS substrate (1) (also known as TFS) with a thickness of 0.20 mm. This

substrate is heated to a temperature of 230 °C by means of heating (2), for example comprising heated guide rolls and/or on the basis of induction, hot air or otherwise. A plastic strip (3) such as a PET plastic strip is produced by applying on each side of substrate (1) molten PET via nozzle (4), (4a) on an internally water-cooled guide roll (5), (5a). The cooled PET strip (3) is then conveyed to the rubber coated contact roll (6). As it travels it is possible to monitor the thickness, colour and strip tension and to trim to the correct width. The thickness of the two strips (3) is between 3 and 100 µm. Prior to commencement of coating the contact rolls (6) do not touch substrate (1), and the two strips are conveyed off, for example rolled up on winders (7).

In order to begin coating, contact rolls (6) are closed, i.e. moved towards substrate (1).

PET strips (3) adhere to substrate (1) and almost simultaneously the pieces of strip (3) between contact roll (6) and winder (7) are cut through. The rubber of rolls (6) is cooled externally, for example by metal cooling roll (8), or by an air-blade on the rubber surface. The coated strip is then subjected to a brief extra heat treatment to 260 °C in order to optimise adhesion. A good product results, particularly suitable for example for the covers of three-piece cans.

Example 2

As in Example 1 but now on the one side of substrate (1) the plastic flowing from nozzle (4a) is a two-layer polypropylene, whereby one of the layers, the adhesion layer, is maleic acid anhydride modified polypropylene; on the other side of the substrate a PET strip is manufactured and supplied via nozzle (4) and cooling roll (5). In this case the preheating temperature of substrate (1) is 200 °C. The thickness of the two strips is between 3 and 100 µm. During the initial contact of the two-layer strip with the substrate

at 200 °C, a temperature above the melting temperature of polypropylene, there is already some adhesion onto substrate (1), while the polypropylene top layer neither sticks to or is damaged by the rubber of contact roll (6) that has a temperature of approx. 90 °C. This adhesion to substrate (1) attains its maximum after approx. 1 second. The coated strip is then subjected to a brief extra heat treatment, for example to 260 °C, in order to optimise the adhesion of both PET and modified PP. A product results, for example particularly suitable for beer bottle crown closures.

Example 3

As in example 1 but now both plastic strips are two-layer polypropylene. Substrate (1) is 0.10 mm thick ECCS and is heated to a temperature of 230 °C. Now a product results with a PP layer on both sides. The higher temperature than in example 2 is necessary because of the low heat content of thin substrate. The product is particularly suitable for example for animal food packaging.

Figures 1, 2 and 3 show different line drawings in accordance with the invention of coating a metal substrate with an in-line manufactured plastic strip. Fig. 2 shows a vacuum chamber (20), an electrostatic edge limiter (9), an air-blade (10) for cooling, a thickness gauge (11), an edging knife (12), a cutting waste extractor installation (13), a temperature gauge (14) and a furnace (15) for heating the coated strip.

It is possible to stretch the plastic strip at a temperature above the glass transition temperature and below the softening temperature of the plastic; in the case of uni-axial stretching an elongation of up to 400% is conceivable. If desired it is possible to provide the plastic strip with openings.

To the expert it will be clear that the invention can be applied for single-side or two-side coating of a metallic substrate with on each side the same plastic, or a different

plastic for example PET or polypropylene or on one side polypropylene and on the other side PET.